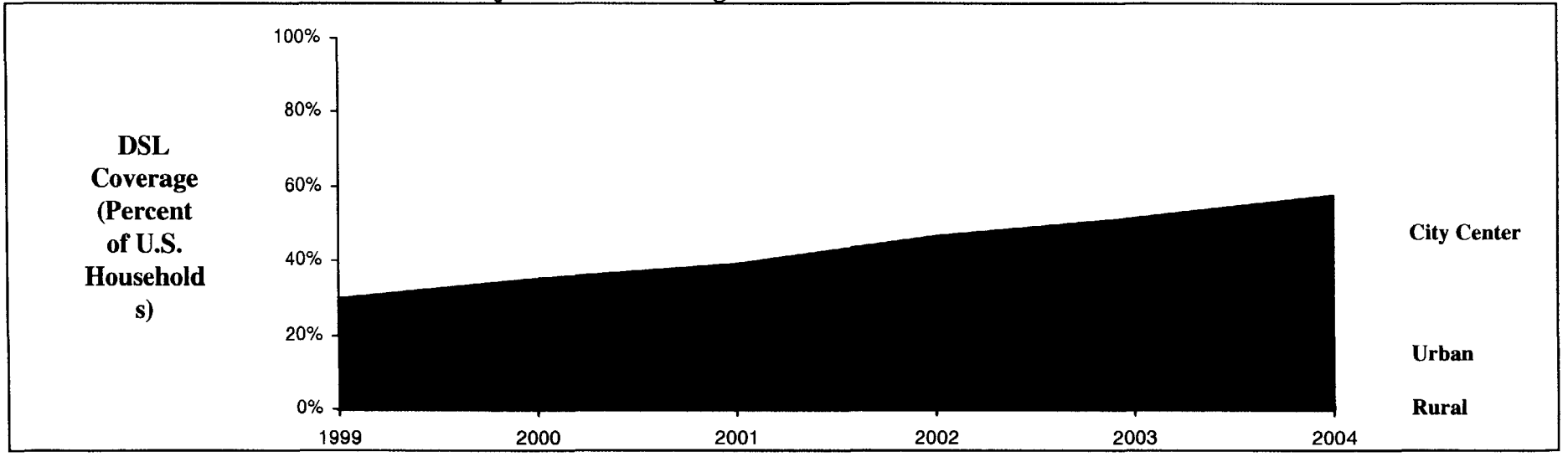
SkyBridge

Additional Coverage May Be Limited by Technology

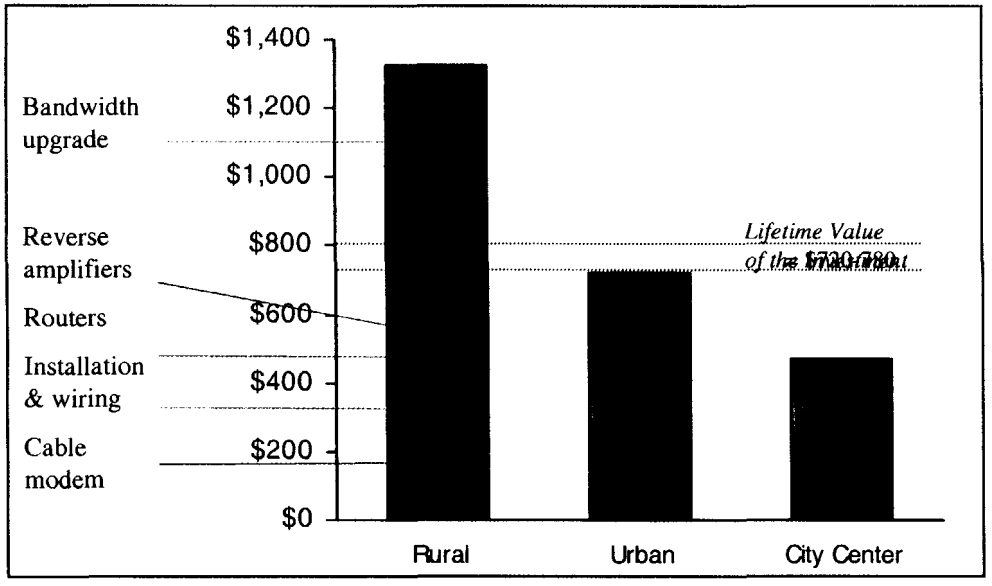
- Distance from Central Office: Limited to lines within 18,000 feet of the central office
- Digital Loop Carrier (DLC): Not feasible for lines served by traditional DLCs
- Bad lines: Older lines with bridge taps and load coils increase provisioning time and costs
- Regulatory: Regulatory rulings on open access impact timing

Projected DSL Coverage in 2004 Leaves >40% Uncovered



SkyBridge

Economics Will Impact Coverage[1]

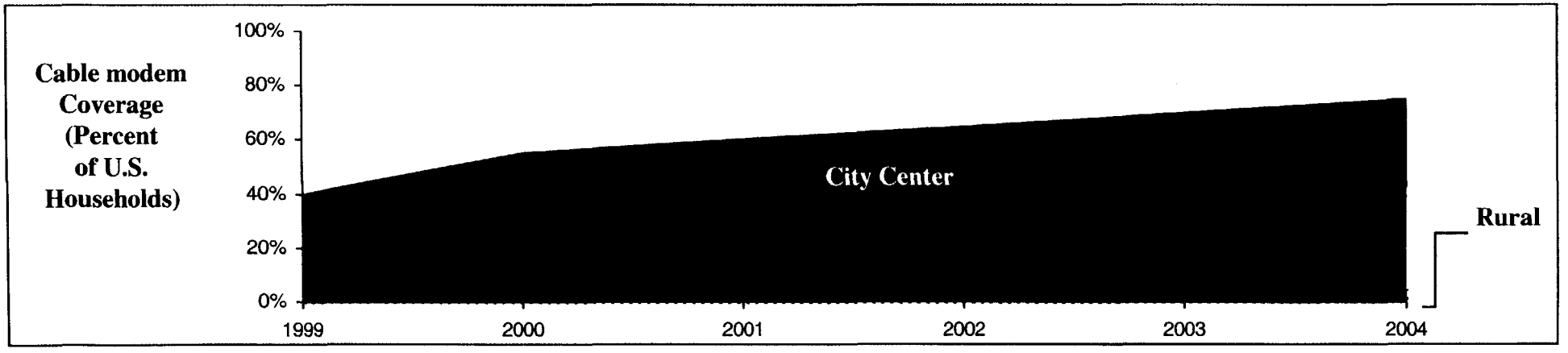


Additional Coverage May Be Limited by Small MSOs

- Small MSOs number over 10,000, and serve approximately 7% of cable subscribers
- Many of these small operators do not have a sufficient customer base to recoup 2-way upgrade investments with Internet access fees
- Some operators are instead choosing provide 1-way Internet access over cable, using a telco return path

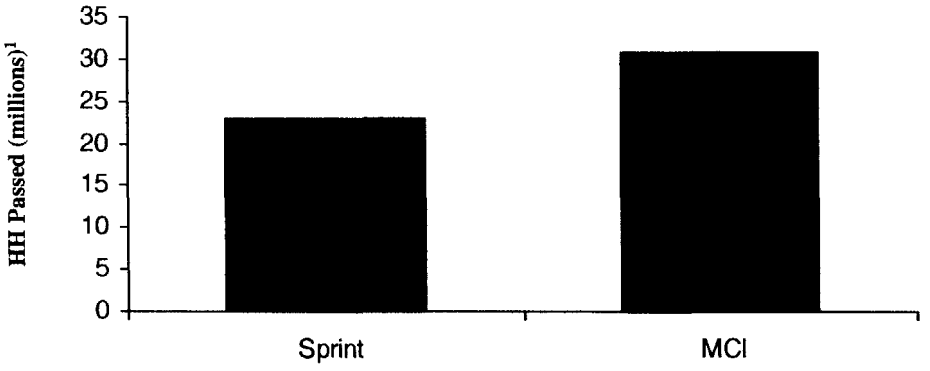
Source: FCC, Allied Business Intelligence, Network, vendor interviews, Mercer analysis.
[1]Estimated cost 2002

Projected Cable Modem Coverage in 2004 Leaves ~26% Uncovered



SkyBridge

Sprint and MCI Cover 54 Million U.S. Homes with Their MMDS Licenses

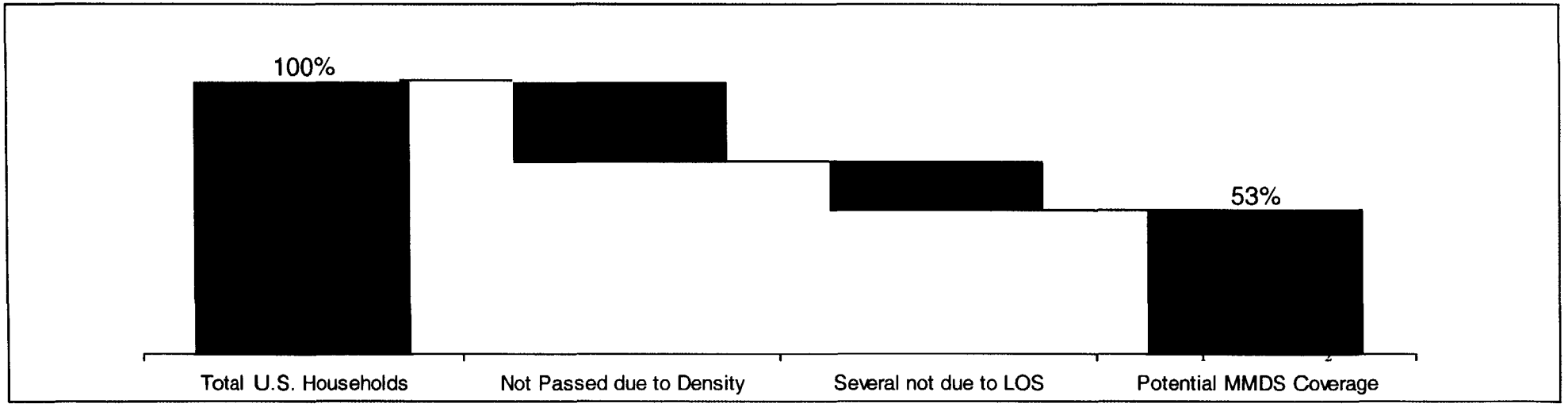


[1]Adjusted for line of sight restrictions.

Additional Coverage May Be Limited by Technology and Acceptance Issues

- Coverage limited to 60% - 80% of households passed due to line of site (LOS) limitations
- Some communities may not accept transmission facilities
- Customer antenna towers are often unsightly
- MMDS speeds degrade as users are added
- Expensive. Cost of CPE and installation ranges from $650 to $1,150 for residential users

Potential MMDS Coverage at End State is 53%



Source: FCC, Allied Business Intelligence, vendor interviews, Mercer analysis.

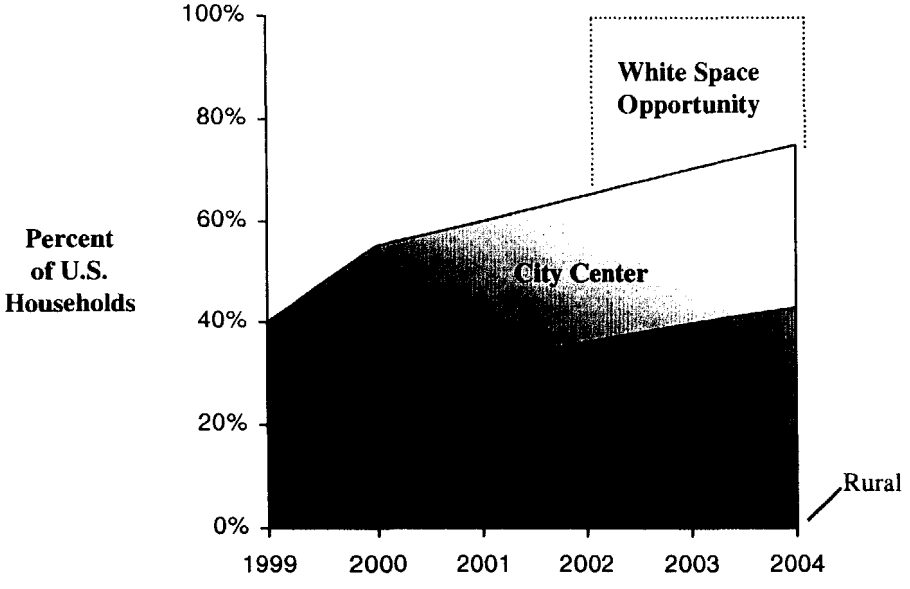
[1]Based on economic analysis, projected MMDS coverage limited to areas with over 90 homes per square mile.

[2]Projected 25% of potential MMDS homes restricted by LOS.

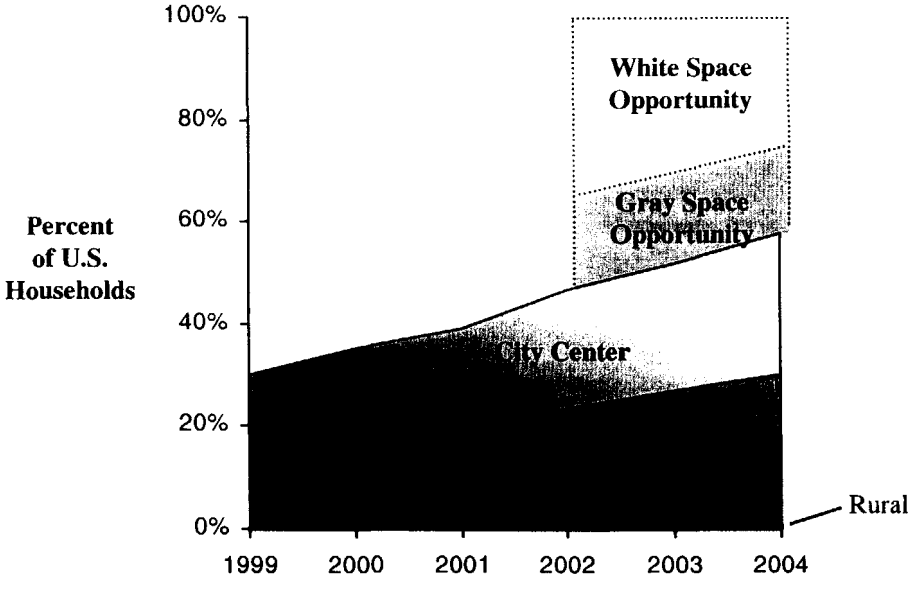
SkyBridge

The White and Gray spaces are large, underserved markets

Predicted Cable Modem Availability

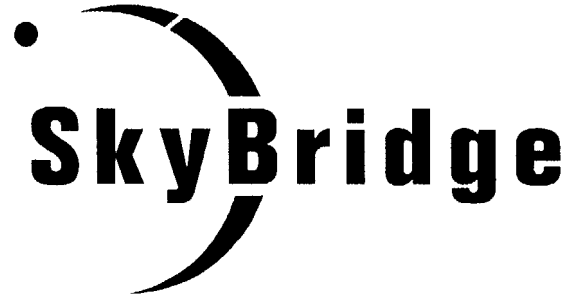


Predicted ADSL Availability



- SkyBridge faces only satellite-based competitors in the White space: (e.g., Spaceway, Astrolink, and Teledesic, if any)
- SkyBridge may also offer competitive services in Gray space areas that have cable modem services but not ADSL

Note: Most MMDS and LMDS coverage will overlap with cable and ADSL coverage.



SkyBridge Spectrum Requirements

SkyBridge

- Number of Users , Calculation of Bandwidth Required
- Deployment of Capacity
- Relay Links
- Situation if Service Links are Limited to 500MHZ on the Down Link

SkyBridge

- Assume capacity per user: 1GByte per month
- Assume aggregated traffic is spread over approximately 200hrs per month (busy hours):
- Number of broadband users ultimately served by 1GHZ BW per satellite transponder and per cell ~ 60,000:
  - 1Gbyte over 200hrs ~ $= 8 \times 10^9 / (200 \times 3600)$
  - 1GHZ ~ 600Mbit/s = 6×10^8 (Including current interference/ sharing constraints)
  - N= 6×10^8/ = <u>60,000 per cell per GHZ</u>

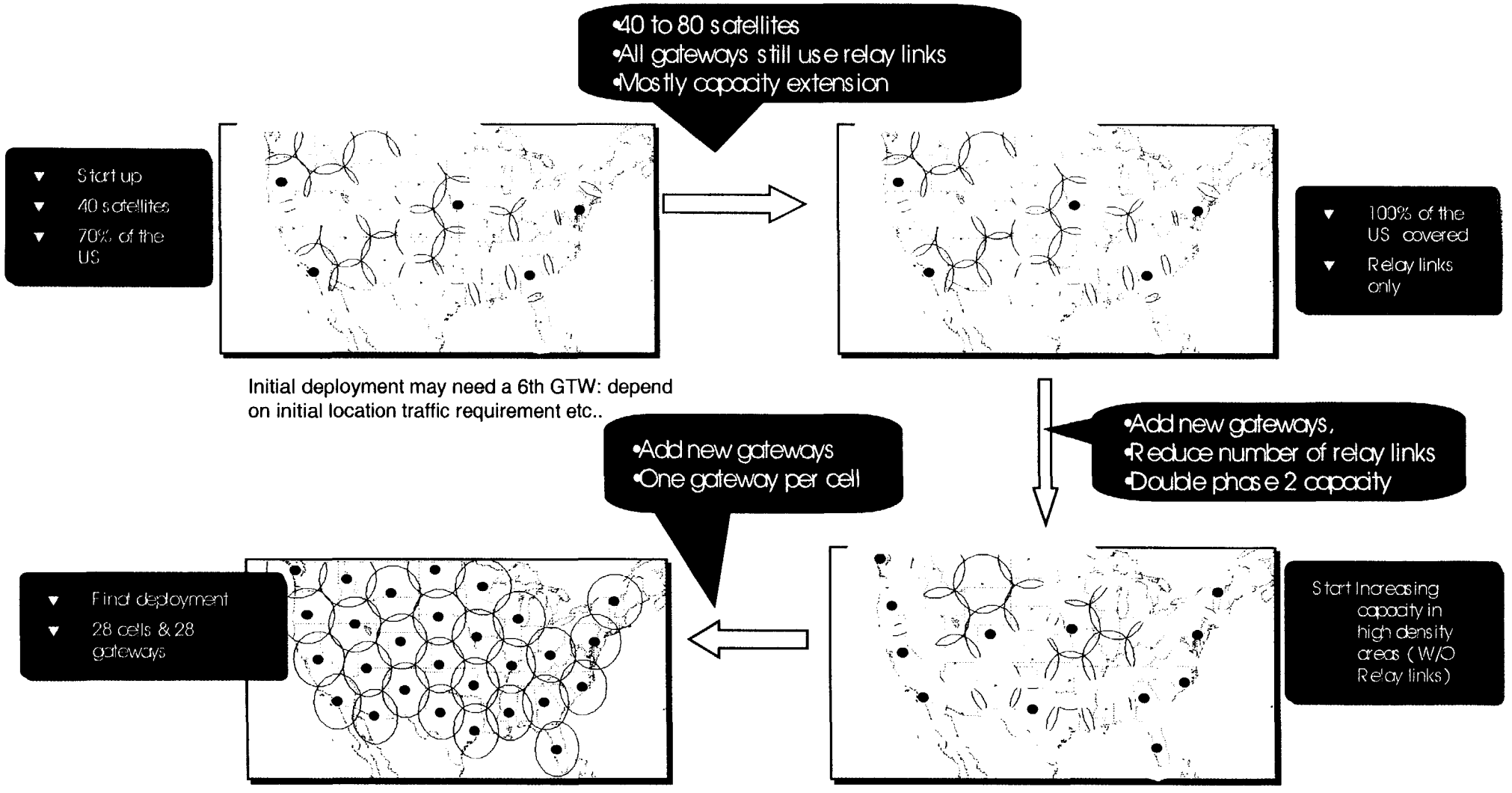
SkyBridge

- Market served with SkyBridge under existing spectrum/sharing limitations
  - Maximum Frequency Reuse Factor = 130 x
    includes :
    - 28 cells + Alaska and Hawaii,
    - Space diversity (number of visible satellites in the various cells)
    - Dual polarization
    - Time zones, and Profiles diversity
    - Interference and EPFD management
  - Equivalent BW (with reuse and over all cells) : ~ 130GHZ
  - Number of Users (who cannot be served by other Internet Access technologies):
    - 2,000,000 residential users
    - 600,000 business sites (6,000,000 Equivalent users)

SkyBridge

- SkyBridge Deployment Plan Provides Ubiquitous Coverage of the USA.
- The Deployment Scheme Addresses Two Independent Questions:
  - The full geographic coverage becomes available as soon as the system gets deployed with a limited number of "gateways":
    - US basic coverage e.g. ~ 28 cells (each 435 Miles in diameter).
    - With "Relay-Links" each gateway can manage several cells. Therefore only a small number of gateways (5 to 6) is needed initially to cover the entire USA. *(universal coverage)*
    - Objective : Ubiquitous service quickly available especially to all low density rural areas.
  - The ramp up for additional capacity over the various cells is incremental and follows the demand.
    - Increasing gateway configuration in already deployed gateways
    - Adding new gateways in already existing cells to serve the increased demand.
    - Use the early revenues from existing gateways to finance the ramp up.

SkyBridge



For illustration purpose only: Location, configuration, # of GTW's is depend upon local market penetration, and system optimization.

SkyBridge

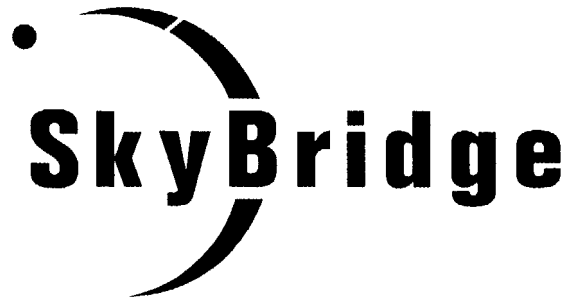
- Frequency reuse scheme requires the usage of 3 sub-bands and two polarizations, ie: The minimum cell reuse pattern to initially cover the USA with Relay Links makes full use of the sub-bands and of the two polarizations:
  - Combination of Interference control between distant cells and,
  - Cross strapping capabilities within all satellites between sub-bands.
  - Eliminating one sub-band would shatter the reuse pattern, and the possibility to cross-strap to adjacent cells from the same satellite.
- Eliminating 500MHz out of the 1GHz band cuts out the necessary sub-bands that permit frequency reuse and Relay links all together.

SkyBridge

- The reuse pattern needed initially for Relay links doesn't match anymore.
  - Direct Impact on capability to offer universal coverage of the USA.
- Gateways would need to be installed in most cells right from day one (Instead of a phased deployment)
  - Increases 5 times the deployment cost of gateways before revenues.

SkyBridge

- At full deployment, the system capacity is **halved**. So would the number of users the system would ultimately be capable of serving.
- If SKB cannot use the relay link scheme along with the necessary frequency reuse pattern between cells in the initial deployment phase, this
  - Eliminates a very significant part of the USA from the initial service coverage, and
  - Would require deploying gateways in most cells, and
  - Much higher up front costs with lower revenues.



SkyBridge System Design Constraints

SkyBridge

Mission of the system:

- service
  - high capacity links
  - reduced round trip delays
- Universal coverage
- Continuous coverage of service areas

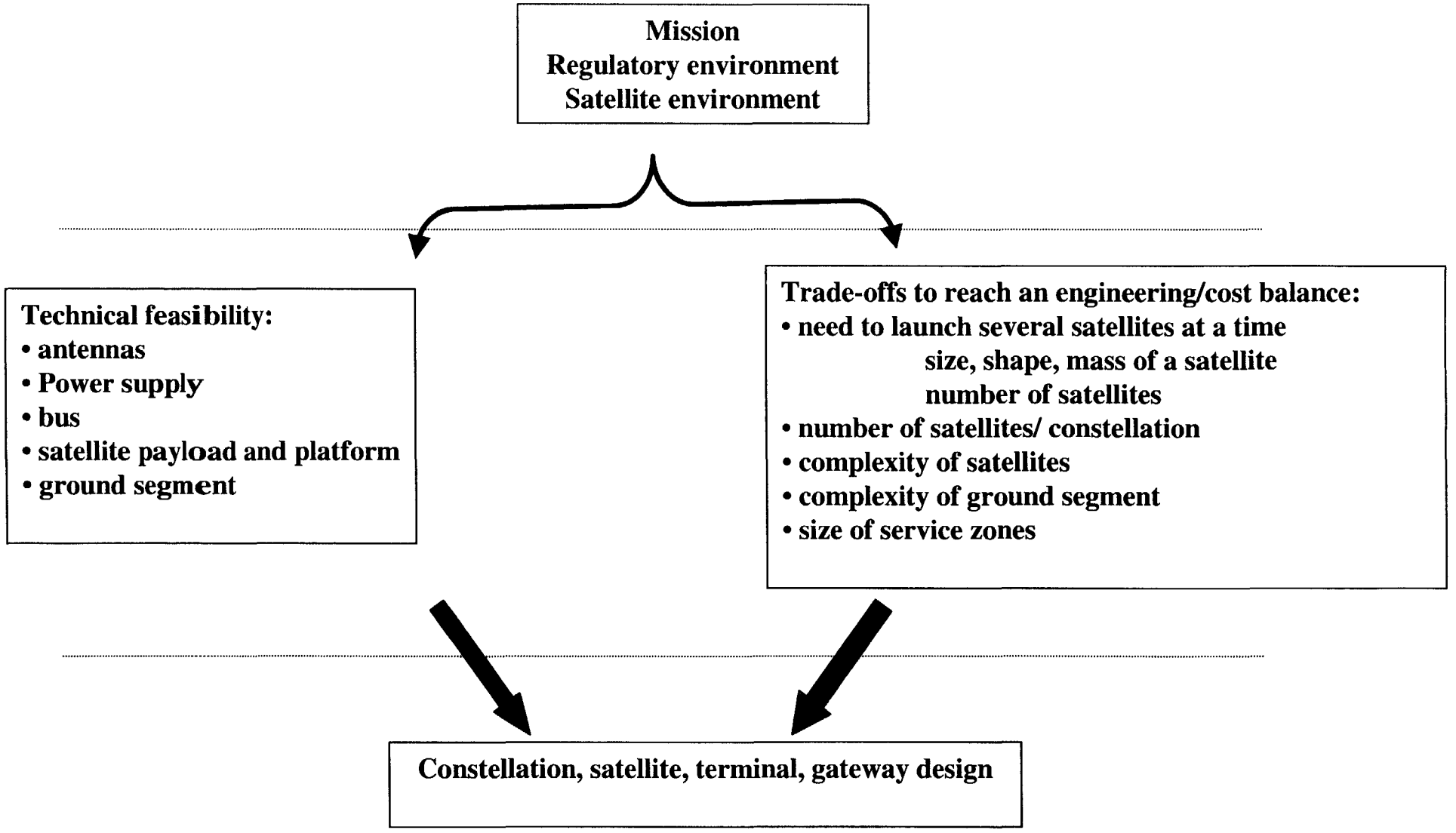
Satellite environment requirements:

- radiation (Van Allen Belts...)

Regulatory environment:

- need to comply with, ITU Radio Regulations and FCC Rules
- need to protect other services

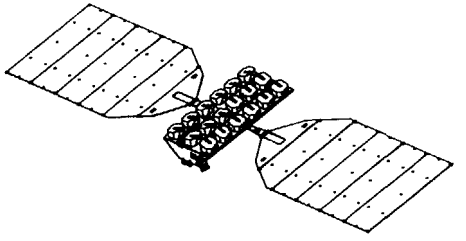
SkyBridge


Mission
Regulatory environment
Satellite environment
Technical feasibility:
• antennas
• Power supply
• bus
• satellite payload and platform
• ground segment
Trade-offs to reach an engineering/cost balance:
• need to launch several satellites at a time
size, shape, mass of a satellite
number of satellites
• number of satellites/ constellation
• complexity of satellites
• complexity of ground segment
• size of service zones
Constellation, satellite, terminal, gateway design

SkyBridge

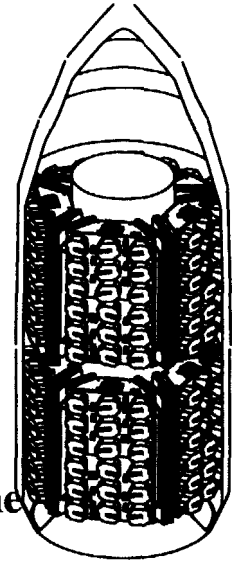
Constellation

- 80 satellites
- Walker constellation at 1469 km altitude
- Allows progressive launch linked to a progressive service deployment
- Continuous coverage of service zone
  - service zones of 700 km in diameter
  - coverage down to 10° elevation
  - universal coverage



Satellite

- Up to 10 satellites per launch



- Continuous coverage of service zone
- Satellite antennas tailored to the service zones

SkyBridge

Consequences for NGSO FSS Terminal Reception of Northpoint Operation

SkyBridge

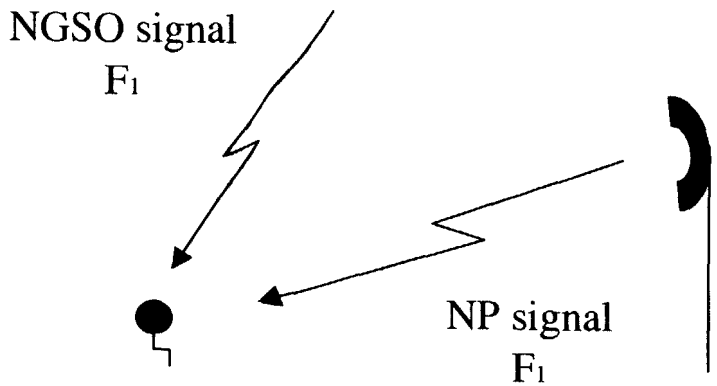
Northpoint (NP) designed to transmit in the side and backlobes of the GSO receivers

NGSO designed to receive and transmit through side and backlobes toward the GSO satellites

In the USA, NGSO earth stations tend to point northward, potentially toward the NP transmitters

SkyBridge

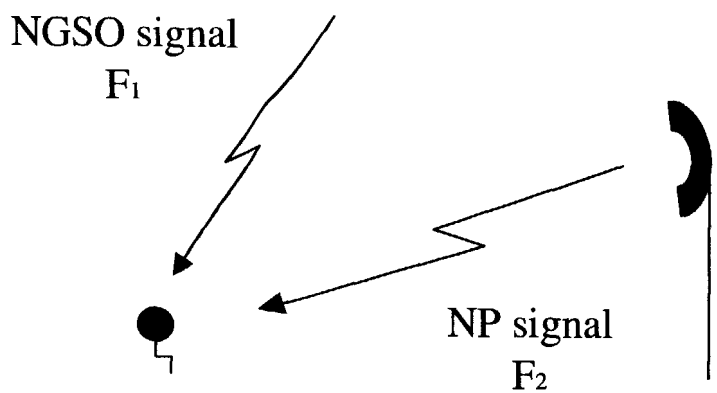
Case 1: NP and NGSO co-frequency operation at F_1



NP signal > NGSO signal

NGSO is interfered with

Case 2



the NGSO has to maintain a data base of forbidden frequencies for all terminals

SkyBridge

SkyBridge user terminals receives in

no filtering on
the Rx 1rst layer

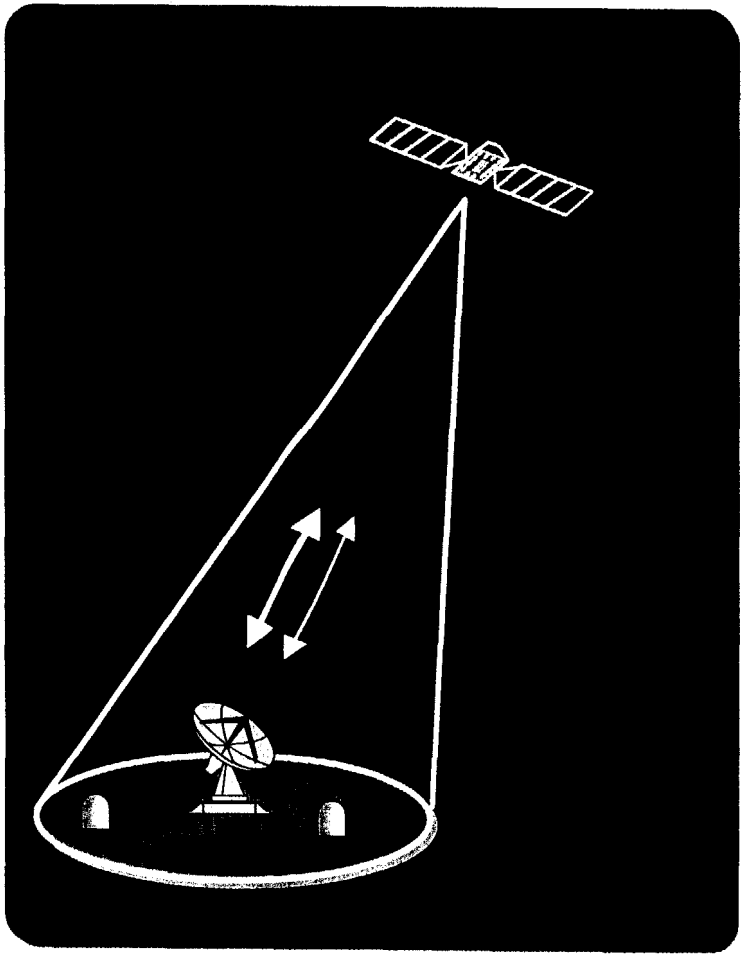
increase in noise temperature of the receiver

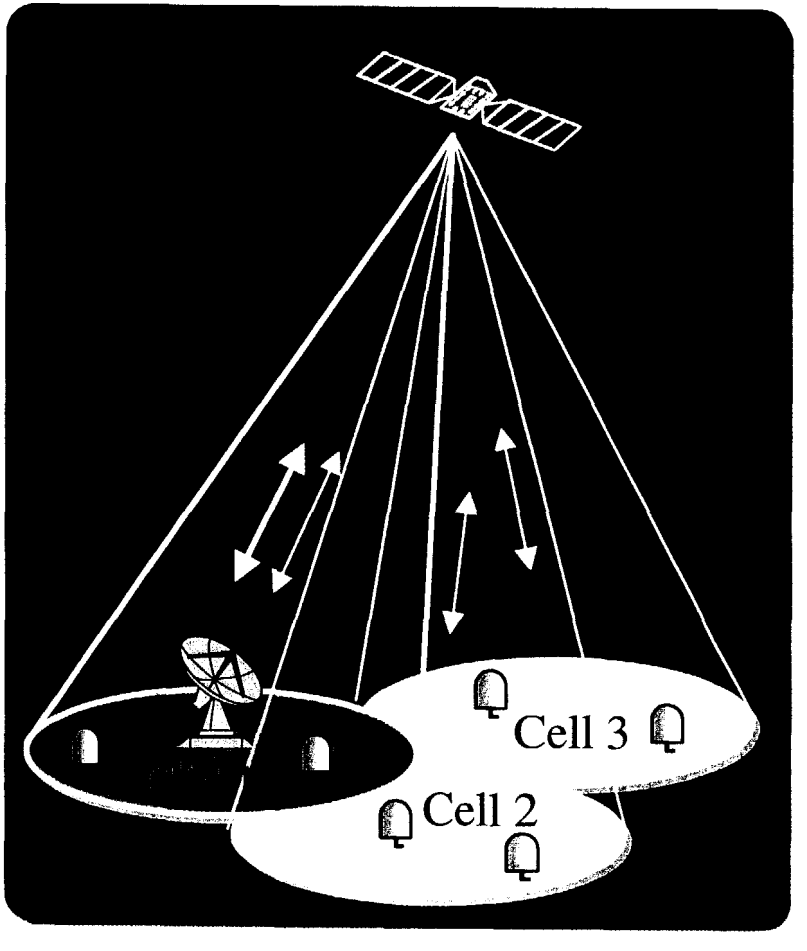
degradation of G/T

reduction of capacity or outage

SkyBridge

Two types of links: gateway cell link, relay links





SkyBridge

Universal coverage offered with relay links